



## National Survey Paper - Denmark

Grohnheit, Poul Erik; Lauritzen, Bent; Sørensen, Anne

*Publication date:*  
2014

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Grohnheit, P. E., Lauritzen, B., & Sørensen, A. (2014). *National Survey Paper - Denmark*. Paper presented at European Atomic Energy Society Combined Meeting 2014, Bordeaux, France.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



**DANSK DEKOMMISSIONERING**

**European Atomic Energy Society  
Combined Meeting  
May 2014**

**NATIONAL SURVEY PAPER  
DENMARK**

**Compiled by  
Poul Erik Grohnheit, DTU  
Bent Lauritzen, DTU  
Anne Sørensen, Danish Decommissioning**

# 1. INTRODUCTION

Danish Decommissioning (DD) [1] and DTU [2] are the Danish representatives in EAES.

DD is responsible for the decommissioning of the nuclear research facilities at Risø. These facilities are the only nuclear facilities in Denmark.

DTU is the Technical University of Denmark. DTU undertakes education, research, public sector consultancy and innovation within the natural and technical sciences, including nuclear technologies.

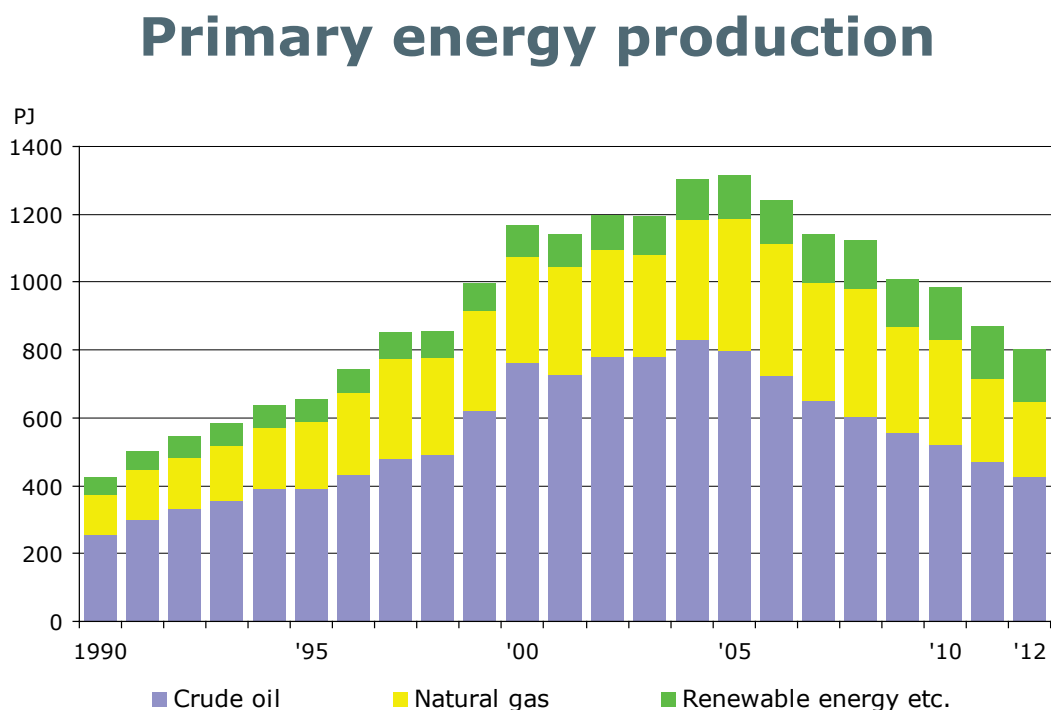
## 2. ENERGY SOURCES AND PRODUCTION

Denmark has been net self-sufficient in energy since 1997. Self-sufficiency is measured in terms of energy production and consumption, calculated on the basis of energy statistics. Around 2005 the degree of self-sufficiency was more than 200 %. This is now declining. Much of the information given in this report concerning energy sources and production has been taken from the web site of the Danish Energy Agency [3] where further details can also be found.

### 2.1 Production of oil and gas

In 2010 the oil and gas production came from 19 fields in the North Sea. Mærsk Oil and Gas AS is operator of 15 of these fields, whilst DONG E&P AS is operator of three and Hess ApS of one.

The operators report how much oil, gas and water is produced from each field to the Danish Energy Agency. Gas and oil reserves in Denmark have been decreasing since 2000, cf. the figure below.



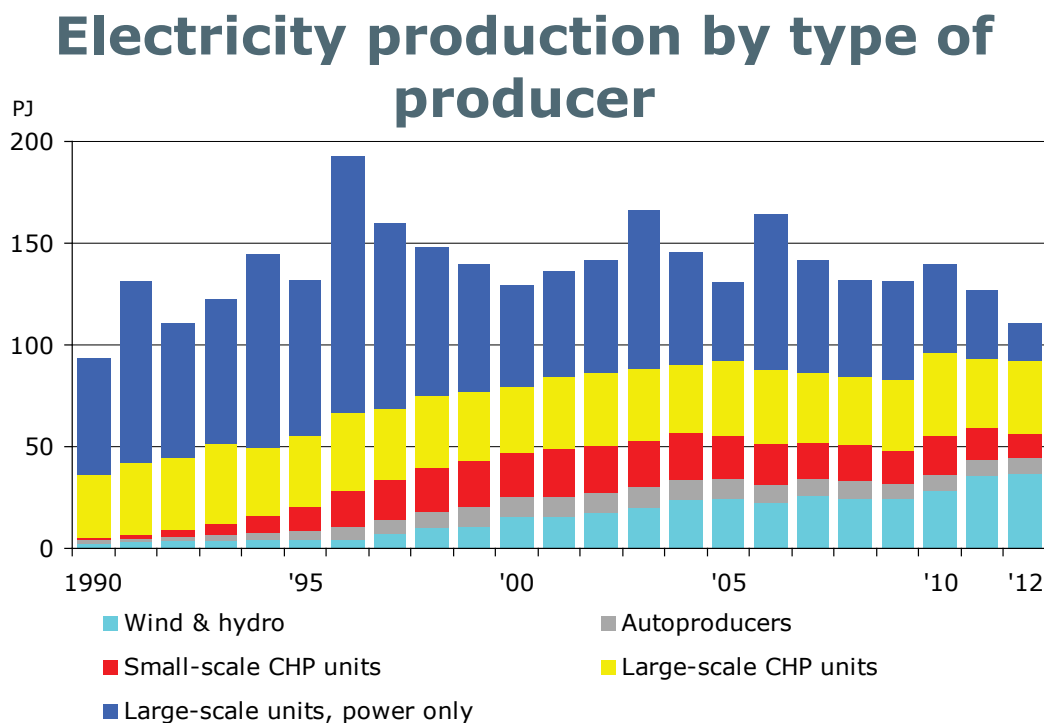
## 2.2 Production of electricity

Electricity generation in Denmark can be divided into three main types of units:

- central power stations with heat extraction to six urban regions
- decentral CHP plants (combined heat and power) with district heating supply for towns and villages
- wind turbines

Central power stations are located on 15 special sites and primarily use coal and to a lesser extent biomass. Decentral CHP plants encompass around 600 generators, industrial and local plants. They typically use natural gas, waste, biogas and biomass. The total capacity of wind turbines was nearly constant from 2002 to 2007, and has increased significantly recent years, mainly by the commissioning of off-shore wind farms. By 2012 wind power's share of domestic electricity supply was 30%. With the planned deployment of new off-shore wind turbines the share will increase to 50 % by 2020. It means that hourly electricity from wind will vary from zero to far more than the domestic consumption. Thus, the key issue for electricity generation in Denmark will be balancing these variations by a wide range of measures: demand response, heat storages in district heating networks supplied by CHP, electric storages, e.g. electric vehicles, and international electricity trade,

The figure below shows the development in the various types of production of electricity (PJ). The very significant variation in power only generation is mainly due to variation in hydro production in Norway and Sweden. The years 1996, 2004, 2006 and 2010 were particular 'dry' years.



## 2.3 The electricity market

Since 2005, the state-owned company Energinet.dk has been in charge of maintaining the overall short-term and long-term security of electricity and gas supply and developing the main Danish electricity and gas transmission infrastructure.

Energinet.dk owns the natural gas transmission system and the 400 kV electricity transmission system, part of the transmission grid, and the 600 MW Great Belt HVDC link, which connects the two Danish systems from mid-2010, and is the co-owner of the electrical interconnections to Norway, Sweden and Germany.

The graph on the following page illustrates the structure of the Danish electricity market.

The transmission system operators have to ensure the function of the system and proper support for producers of environmentally-friendly electricity.

Transmission companies own and run the transmission grid.

Grid companies own and run the distribution grid.

Trading companies trade electricity on a purely commercial basis.

Electricity companies with an obligation to supply are trading companies obliged to supply electricity to those customers who have not chosen their own supplier in the free market. All such companies have to provide electricity to all customers at reasonable terms and competitive prices.

The Danish Energy Agency (in few years called The Danish Energy Authority) lays down rules, grants approvals for generating and transmission plants and systems etc.

The Danish Energy Regulatory Authority (DERA) monitors prices and terms for the collective supply companies and handles complaints against them.

The Energy Supplies Complaint Board is a private board that handles civil legal complaints between private customers and the energy companies. It also considers cases concerning customer agreements for the purchase and supply of electricity, gas and heat. Finally, it considers cases related to other related goods or services.

The Energy Board of Appeal is the body that addresses appeals resulting from decisions passed by DERA and the Energy Agency.



(Finland, Sweden, Norway (divided in two or more areas), and Denmark (east and west) separate hourly area prices are calculated

In addition to the spot market, Nord Pool also operates a financial market with futures and forward prices and a range of other prices, including the European Emission Trading system for CO<sub>2</sub> allowances.

### Consumer electricity prices

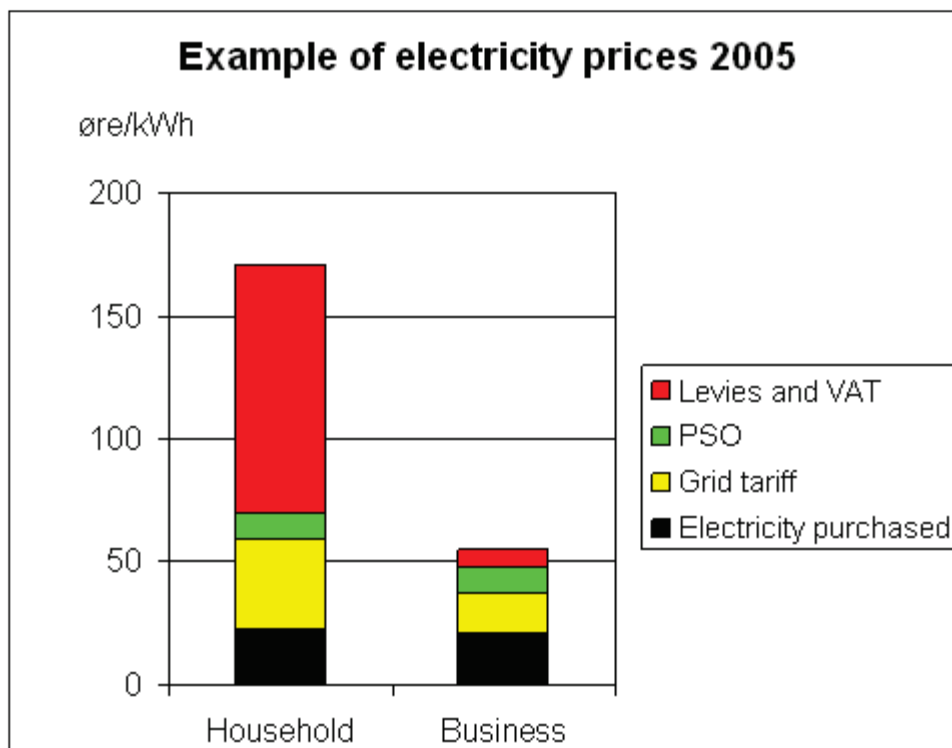
The total price paid by consumers consists of the following elements:

- market electricity price
- grid tariffs, i.e. payments to the grid owner and transmission system operator for transmission
- PSO (public service obligation)
- subscription to grid owner and electricity dealer
- plus state levies and VAT

The total price depends on:

- the consumer category
- grid owner
- location
- market prices etc.

The figure below illustrates the composition of the electricity price for a household with a consumption of 4,000 kWh/year and a business with a consumption of 1,000 MWh/year. The figure is based on numbers from 2005, but the changes since have not been substantial.



## 2.4 Heat Supply in Denmark

More than 50% of the market for space heating is supplied by district heating (DH), which is being expanded in areas with sufficient heat densities. Areas with less heat density are typically supplied by natural gas for individual boilers. Oil boilers and direct electric heating are used mostly in areas with low densities. DH is produced by incineration of urban waste, combined heat and power plants (CHP), mainly from large plants, and peak-load boilers. More than two-thirds of thermal electricity and district heating generation is CHP. Heat storages are important in district heating systems to allow electricity generation in CHP plants to respond to variations in wind power. Electrical driven heat pumps are supported to replace direct electric heating and oil boilers, which will add to the flexibility in electricity generation.

## 2.5 Nuclear power

For many years nuclear power has not been an issue in Denmark. The size of nuclear units and their operation pattern is becoming increasingly incompatible with the Danish electricity system, because the key issue is balancing the variations in wind power on a few-days or weekly basis – in addition to the traditional seasonal and annual variations of hydro power in Scandinavia.

Nuclear R&D is limited to the level required to maintain an expertise allowing the government to make independent national assessments, to support the operation and decommissioning of the nuclear facilities at Risø, and to ensure a scientific and technical backup for the authorities. Nuclear related research in Denmark is mainly concerned with radiation protection, nuclear emergency preparedness, radiation in the environment, and applications of nuclear methods in research, industry and the health sector.

DTU and a few other Danish institutions participate in the Euratom Nuclear Fission Research Programme of the European Commission, particularly within radiation protection, and also in the Nordic Nuclear Safety Research Programme.

DTU also participates in the European Fusion Energy Research Programme.

Danish Decommissioning participates in a number of activities under the IAEA related to decommissioning. A DD staff member is also involved in work under the ICRP.

## 3. POLICY AND R&D IN NON-NUCLEAR ENERGY FIELDS

The Danish energy policy has three focus points: security of supply, climate impact and cost effectiveness. The Danish government stated in its government platform from January 2007 that Denmark should be a green and sustainable society with a visionary climate and energy policy (<http://www.ens.dk/en-US/policy/Sider/Forside.aspx>). To meet these political goals, various funding schemes offer public grants to R&D in new energy technologies.

*EUDP or Programme for Energy Technology Development and Demonstration* supports the development and demonstration of new energy technologies. The program is headed by an independent Board, appointed by the Minister for Climate and Energy, which decides on EUDP priorities. Administration of EUDP will be carried out by a secretariat in the Danish Energy Agency.



*Energinet.dk* (the electricity and gas system operator) provides funding for energy RD&D projects concerning environmentally friendly production of power. Further information on [www.energinet.dk](http://www.energinet.dk).

*Dansk Energi* – (*The Danish Energy Association*) is a commercial and professional organisation for Danish energy companies. It provides funding for energy RD&D projects concerning efficient use of electricity. The programme focus areas are buildings, LED (Light Emitting Diode) lighting and cooling technology. Further information is available on [www.danskenergi.dk](http://www.danskenergi.dk)

*The Strategic Research Council* supports research in areas politically defined. In 2009 – 2010 the focus is on research themes such as: future energy systems, competitive, environmental technology and the future climate, and a climate adaptation. Further information is available on <http://en.fi.dk/>.

*Højteknologifonden* (the Danish National Advanced Technology Foundation) aims to enhance growth and strengthen employment by supporting strategic and advanced technological priorities within the fields of research and innovation. The foundation shall make a special effort to promote research and innovation in small and medium-sized enterprises. Support is not restricted to energy technologies, but so far between 20 % and 30 % of the budgets have been allocated to energy technology projects. Further information can be found on [www.hoejteknologifonden.dk](http://www.hoejteknologifonden.dk).

## **4. DECOMMISSIONING OF THE NUCLEAR FACILITIES AT THE RISØ SITE**

### **4.1. Introduction**

The Risø site is located about 6 km north of the city of Roskilde (about 40 km west of Copenhagen) at the shore of Roskilde Fjord as shown in the photo below. Reactor DR 2 can be seen in the foreground. DR 3 is situated at the left hand side of the peninsula. The Hot Cell facility is the light area with a smokestack seen above DR 2. Decommissioning of the nuclear research facilities at the site is carried out by the state organisation Danish Decommissioning, which is organisationally and financially independent from the research laboratory



## **4.2. Decommissioning progress since the previous report to the EAES CM**

### **Research reactor DR 3**

DR 3 was a 10 MW tank type reactor with heavy water as moderator and coolant and a graphite reflector. It is of the DIDO/PLUTO family designed in the UK. DR 3 went critical for the first time in January 1960 and since then was operated in a 4-week cycle with 23 days of continuous operation and 5 days shut down. It had its last operation in April 2000 and was finally shut down in September 2000. After the final shut down, the fuel elements were removed and shipped to the US and also the heavy water was shipped away for use as feed in heavy water power reactors.

All peripheral and only slightly active systems have been dismantled. The decommissioning plan for the final dismantling was approved in December 2011. Funding for the final dismantling has been granted by the Parliament's Finance Committee, and actual dismantling of the internal, very active, parts of the reactor is ongoing. One very important milestone was the removal of the top shield plug. It was replaced with a shielding plate. The new shielding plate is equipped with lead-through holes to allow remote handling and removal of internal parts.

The decommissioning of DR 3 is expected to be completed by 2018.



*DR 3 prepared for the removal of the top shield plug*

## **The Hot Cell facility**

The Hot Cell facility was commissioned in 1964 and operated until 1989. Following a partial decommissioning from 1990 to 1994, only a row of six concrete cells remains as a sarcophagus inside the building. The remaining part of the building has been free released and is now being used for other purposes by Risø DTU.

The decommissioning of the facility will comprise decontamination of the interior surfaces of the cells by remote controlled grit blasting, followed by a more “hands-on” removal of possible remaining contamination. The surfaces are painted steel lining and steel tables. The majority of the contamination consists of  $^{60}\text{Co}$ , partly in the form of  $1\text{ mm}^3$  pellets, and  $^{137}\text{Cs}$  plus actinides from the post irradiation examinations of fuel elements.

The project has suffered a number of delays, due to many difficulties, among others ventilation systems and remote controlled processes.

## **The Fuel Fabrication Plant**

The fuel fabrication plant has been used for the fabrication of fuel elements for DR 3 using enriched uranium powder. The production ceased in 2000 when the reactor was closed. The decommissioning started in 2013 and is expected to be completed by the end of 2014. The work



includes cleaning or removal of inventory and equipment. The decommissioning will be followed by clearance measurements of the hall.



*Fuel Fabrication Plant: Removal of floor*

### **4.3. Final disposal of radioactive waste**

In 2003 The Danish Parliament decided that a final repository for Low- and Intermediate level radioactive waste shall be established in Denmark. Until now the work has included preliminary studies identifying 6 preferable sites from a geological point of view, and further geological investigations. By the end of 2012 The Danish Parliament decided to add two other tracks to the work for a long term solution for the Danish waste: Long term storage or export.

In the final disposal track Environmental Assessments including public hearing is ongoing and expected to be completed by the end of 2014. In parallel work preparing a "Basis for decision" concerning long term storage and investigations on export possibilities have to be completed this year. Based on these studies a political decision is expected.

At the moment all radioactive waste in Denmark is stored at the Risø-site.

## **5. References**

1. Danish Decommissioning <http://www.dekom.dk/english.aspx>
2. DTU, Center for Nuclear Technologies, <http://www.nutech.dtu.dk/>
3. Danish Energy Agency, <http://www.ens.dk/en-us/Sider/forside.aspx>